

Disclaimer:

This English translation is produced by machine translation and may contain errors. The JPO, the INPIT, and those who drafted this document in the original language are not responsible for the result of the translation.

Notes:

1. Untranslatable words are replaced with asterisks (***).
2. Texts in the figures are not translated and shown as it is.

Translated: 04:56:21 JST 08/31/2009

Dictionary: Last updated 08/17/2009 / Priority: 1. Electronic engineering / 2. Mathematics/Physics / 3. Mechanical engineering

FULL CONTENTS

[Claim(s)]

[Claim 1]A robot constituted by two or more motors, and a control part which controls said motor, A disturbance detection machine which presumes disturbance torque which inputs torque and speed of said motor and starts said motor, A control unit of a robot which has a judging means which compares with a threshold a differential means which differentiates a signal corresponding to disturbance torque outputted from said disturbance detection machine, and a signal outputted from said differential means.

[Claim 2]A control unit of the robot according to claim 1 which raised a threshold of a wrist axis when working speed of said basic shaft is quick compared with a threshold about a wrist axis when working speed of one or more basic shafts and said basic shaft of a robot which has one or more wrist axes provided at a tip is slow.

[Claim 3]A control unit of the robot according to claim 1 or 2 characterized by comprising the following.

A control part which controls said motor of a robot constituted by two or more motors.

A disturbance detection machine which presumes disturbance torque which inputs torque and speed of said motor and starts said motor.

A filter part which cuts only a frequency component with disturbance torque outputted from said disturbance detection machine.

[Claim 4]A control part which controls two or more motors which drive a robot, and a disturbance detection machine which presumes disturbance torque which inputs torque and speed of said motor and starts a robot, A mean value calculating means which computes an average per setup time of disturbance torque outputted from said disturbance detection machine, A control unit of a robot which has a judging means which compares a memory measure which memorizes average disturbance torque computed by said mean value

calculating means with average disturbance torque memorized by said memory measure and the present disturbance torque.

[Claim 5]A control part which controls two or more motors which drive a robot, and a disturbance detection machine which presumes disturbance torque which inputs torque and speed of said motor and starts a robot, A mean value calculating means according to speed which computes an average per time of disturbance torque by changing a setup time according to speed of said robot, A control unit of a robot which has a judging means which compares a memory measure which memorizes average disturbance torque computed by mean value calculating means according to said speed with average disturbance torque memorized by said memory measure and the present disturbance torque.

[Claim 6]A control unit of the robot according to claim 4 which shortens a setup time when speed of a robot is quick to a setup time when a mean value calculating means according to speed has a slow speed of a robot.

[Claim 7]A control unit of the robot according to any one of claims 4 to 6 which memorizes average disturbance torque computed in a setup time in front of one to the present disturbance torque to a memory measure.

[Claim 8]A control unit of the robot according to any one of claims 1 to 7 which inputs a signal from a disturbance detection machine of each axis of each robot by a robot to which coordination operation of between two or more control parts is connected and carried out by a means of communication.

[Claim 9]A control unit of the robot according to any one of claims 1 to 8 which totals each axis by a means of communication which inputs a signal from a disturbance detection machine for every axis of a robot which has one or more basic shafts and one or more wrist axes provided at a tip.

[Claim 10]A control method of a robot characterized by comprising the following.

A step which presumes disturbance torque which inputs torque and speed of said motor of a robot constituted by two or more motors, and starts said motor.

A step which differentiates a signal corresponding to said disturbance torque.

A step which compares a signal computed at said step to differentiate with a threshold.

[Claim 11]A control method of the robot according to claim 10 which raised a threshold of a wrist axis when working speed of said basic shaft is quick compared with a threshold about a wrist axis when working speed of one or more basic shafts and said basic shaft of a robot which has one or more wrist axes provided at a tip is slow.

[Claim 12]A control method of the robot according to any one of claims 10 to 11 which cuts only a step which inputs torque and speed of said motor of a robot constituted by two or more motors, and presumes disturbance torque of said motor, and a frequency component with said

computed disturbance torque with a filter.

[Claim 13]A control method of a robot characterized by comprising the following.

A step which presumes disturbance torque which inputs two or more torque and speed of a motor which drive a robot, and starts a robot.

A step which computes average disturbance torque per setup time of said disturbance torque.

A step which memorizes said computed average disturbance torque.

A step which compares said memorized average disturbance torque with the present disturbance torque.

[Claim 14]A control method of a robot characterized by comprising the following.

A step which presumes disturbance torque which inputs two or more torque and speed of a motor which drive a robot, and starts a robot.

A step which computes average disturbance torque per time of disturbance torque by changing a setup time according to speed of said robot.

A step which memorizes said computed average disturbance torque.

A step which compares said memorized average disturbance torque with the present disturbance torque.

[Claim 15]A control method of the robot according to claim 12 which shortens a setup time when speed of a robot is quick to a setup time when a mean value calculating means according to speed has a slow speed of a robot.

[Claim 16]A control method of the robot according to any one of claims 13 to 15 of having a step which memorizes average disturbance torque computed in a setup time in front of one to the present disturbance torque.

[Claim 17]A control method of the robot according to any one of claims 10 to 16 which inputs a signal from a disturbance detection machine of each axis of each robot by a robot to which coordination operation of between two or more control parts is connected and carried out by a means of communication.

[Claim 18]A control method of the robot according to any one of claims 10 to 17 input a signal from a disturbance detection machine for every axis of a robot which has one or more basic shafts and one or more wrist axes provided at a tip, and using total of disturbance torque.

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to collision judgement processing of robotic

control.

[0002]

[Description of the Prior Art]In order to prevent conventionally breakage of the mechanism part by the collision to an obstacle, a work, etc. of an industrial robot which are driven with a servo motor, collision detection processing is performed. And that collision detection presumes the disturbance torque generated in a servo motor by a disturbance estimation observer, when a mechanism part collides, and if it becomes more than the threshold to which this estimated disturbance torque was set, it will be judged that the collision occurred. However. [the disturbance torque generated when a robot collides] Since mechanical frictional force, the reaction force of a spring system, and the gravity concerning machinery are included, as it is in JP,H3-196313,A, the method of making the threshold of a collision judgement larger than the aforementioned frictional force, reaction force, and gravity, and setting it as a value smaller than the intensity-proof of a mechanism part is used. This composition is shown in drawing 17 and it explains below. First, in the disturbance presumption machine 2, disturbance torque is presumed from the instruction torque and motor actual speed which are computed by the control means 1. Next, by the judging means 4, the comparison with the presumed disturbance torque and the threshold set up beforehand is performed, when disturbance torque is over the threshold, it judges that the collision arose, and processing of breakage prevention is performed by the protection treating part 5.

[0003]

[Problem to be solved by the invention]Since the reaction force of spring systems, such as frictional force produced when a moving part moves to the disturbance torque presumed with a disturbance presumption machine in the above-mentioned conventional collision judgement processing and gravity concerning machinery, and a slowdown machine, is contained, it is difficult to presume only a part for the disturbance torque correctly produced by collision. Therefore, the threshold of a collision judgement cannot be set up smaller than the level of disturbance torques other than a collision. Since gravity, frictional force, and reaction force always change, depending on a posture or speed, detection to a collision judgement will take time again.

[0004]Only by judging the presumed conventional disturbance torque to be a threshold, when the big inertial force by a basic shaft was added to a mechanism part like a robot wrist axis, this inertial force might be judged to be the disturbance torque by collision, and the erroneous decision of the collision might be produced.

[0005]

[Means for solving problem]To achieve the above objects, the 1st composition of this invention establishes the differential means which differentiates the disturbance torque computed with a disturbance detection machine, and the judging means which carries out the comparison test

of the differentiated signal and the threshold.

[0006]The 2nd composition of this invention establishes the threshold alteration means into which the judgment threshold of a wrist axis is changed according to the working speed of a robot basic shaft.

[0007]The 3rd composition of this invention provides a filter part which cuts the gravity component which starts a mechanism part among the disturbance torques computed with a disturbance detection machine.

[0008]The mean value calculating means which computes the average per setup time of the disturbance torque to which the 4th composition of this invention is outputted from a disturbance detection machine, The judging means which compares the memory measure which memorizes the average disturbance torque computed by said mean value calculating means with the average disturbance torque memorized by said memory measure and the present disturbance torque is established.

[0009]The 5th composition of this invention establishes the mean value calculating means according to speed which computes the average per time of disturbance torque by changing a setup time according to the speed of a robot.

[0010]The 6th composition of this invention establishes the mean value calculating means according to speed which shortens a setup time when the speed of a robot is quick to a setup time when the speed of a robot is slow.

[0011]The 7th composition of this invention establishes the memory measure which memorizes the average disturbance torque computed in the setup time in front of one to the present disturbance torque.

[0012]The 8th composition of this invention establishes the high order judging means which performs a collision judgement by the output from all the disturbance detection machines in the control part of each motor of the robot which carries out coordination operation in two or more robots.

[0013]In the robot which has a joint more than biaxial, the 9th composition of this invention totals the disturbance torque for every axis, and establishes the disturbance torque sum means which performs a collision judgement by the total.

[0014]The 1st method of this invention differentiates the computed disturbance torque, and carries out the comparison test of the signal and threshold which were differentiated.

[0015]According to the working speed of a robot basic shaft, the judgment threshold of a wrist axis is changed and the 2nd method of this invention carries out a comparison test to the disturbance torque computed.

[0016]The 3rd method of this invention cuts the gravity component which starts a mechanism part among the disturbance torques computed with a filter, and carries out the comparison test of the signal and threshold after the filter processing.

[0017]The 4th method of this invention computes the average per setup time of the disturbance torque outputted from a disturbance detection machine, makes it memorize as average disturbance torque, and carries out the comparison test of the average disturbance torque made to memorize and the present disturbance torque.

[0018]The 5th method of this invention computes the average per time of disturbance torque by changing a setup time according to the speed of a robot.

[0019]The 6th method of this invention shortens a setup time when the speed of a robot is quick to a setup time when the speed of a robot is slow.

[0020]Average disturbance torque computed in a setup time in front of one to the present disturbance torque is used for the 7th method of this invention.

[0021]The 8th method of this invention performs a collision judgement including a robot which carries out coordination operation with two or more robots by disturbance torque of all the axes computed in each motor control section.

[0022]In a robot which has a joint more than biaxial, the 9th composition of this invention totals disturbance torque for every axis, and performs a collision judgement by the total.

[0023]

[Mode for carrying out the invention]According to the 1st composition and 1st method of above-mentioned this invention, a collision judgement can be carried out to an instant after a collision occurrence of mechanism parts, such as a robot.

[0024]Next, according to the 2nd composition and 2nd method of above-mentioned this invention, an erroneous decision of a collision occurrence is avoidable according to inertial force produced by high-speed operation of a basic shaft.

[0025]Next, according to the 3rd composition and 3rd method of above-mentioned this invention, a gravity component contained in disturbance torque can be cut.

[0026]According to the 4th composition and 4th method of above-mentioned this invention, a threshold which judges a collision of mechanism parts, such as a robot, can be set up small, and a collision can be detected in a short time.

[0027]According to the 5th composition and 5th method of above-mentioned this invention, the disturbance value at the time of the collision used for the comparison with a threshold is changeable according to speed.

[0028]According to the 6th composition and 6th method of above-mentioned this invention, even when the working speed of a robot is quick, the erroneous decision of a collision occurrence can be avoided also to a sudden change of the detection disturbance value by a posture change etc.

[0029]According to the 7th composition and 7th method of above-mentioned this invention, the threshold which judges the collision of mechanism parts, such as a robot, can be set up still smaller, and a collision can be detected further in a short time.

[0030]Next, according to the 8th composition and 8th method of above-mentioned this invention, a collision judgement is detectable promptly by the estimated disturbance torque of all the motion axes of the robot which is carrying out coordination operation.

[0031]Next, according to the 9th composition and 9th method of above-mentioned this invention, the disturbance torque computed by all the motors is totaled, and a collision judgement can be detected in an instant.

[0032](Embodiment 1) A 1st embodiment of this invention is described below.

[0033]In describing an embodiment of the invention below, the disturbance presumption machine is used as a way stage which detects the disturbance torque concerning a robot. However, to say nothing of being good also as composition especially using a sensor etc., the control unit and the control method of this invention can be constituted irrespective of the detecting method of disturbance torque.

[0034]First, the control constitution for performing a collision judgement in an instant is shown in drawing 1. The disturbance torque T_d is computed with the disturbance presumption machine 2 from the instruction torque T_c outputted from the control means 1, and actual speed ω of a motor. Next, the computed disturbance torque T_d is differentiated in the differential means 3, and is outputted to the judging means 4 as a differential signal corresponding to the disturbance torque T_d . In the judging means 4, the comparison test of the threshold set up beforehand and the differential signal inputted is performed, it judges that the collision arose, when a threshold is exceeded, and instructions of protection processing execution are taken out to the protection treating part 5, and breakage protection of a driving machine is performed.

[0035]As shown in drawing 2 (a), change of the disturbance torque T_d when a collision occurs goes up to an upward slant to the right almost uniformly, and the disturbance torque T_d exceeds a threshold after the time T_s until a collision judgement is carried out from a collision occurrence. To it, as shown in drawing 2 (b), in signal dT_d/dt which differentiated the disturbance torque T_d , simultaneously with a collision occurrence, it turns out that a value increases steeply according to inclination of the disturbance torque T_d , and the threshold set up in an instant (between $dT_s(es)$) is exceeded.

[0036]Therefore, a collision judgement can be carried out to the instant after a collision occurrence.

(Embodiment 2) A 2nd embodiment of this invention is described below.

[0037]In order to explain simply, explanation is given below by the robot arm of 2 flexibility which comprises the motor 6 equivalent to a basic shaft as shown in drawing 3, the motor 7 equivalent to a wrist axis, the link 8 and also the fixed stand 9, and the load 10. About the same composition as the 1st invention, identical codes are attached and it carries out abbreviated [of the explanation].

[0038]First, as shown in drawing 3, a robot arm connects the link 8 to the axis of rotation of the motor 6 fixed to the fixed stand 9, attaches the motor 7 at the tip of the link 8, and the load 10 is attached to the motor 7, and it is constituted. And the position of the load 10 of an arm tip is controlled by controlling the rotation angle of the motor 6 and the motor 7. At this time, the inertial force F_i on the torque of the motor 6 is working on the motor 7.

[0039]Therefore, when the direction of rotation of the motor 6 is reversed, the inertial force F_i will be added to the motor 7 as disturbance torque. Then, when the motor 6 is reversed at speed that the inertial force F_i exceeds a threshold, the erroneous decision of a collision occurrence will be performed by the motor 7.

[0040]Then, in order to take into consideration the inertial force of the motor 6 which is a basic shaft, it has composition shown in drawing 4. The composition of drawing 4 is explained below.

[0041]In the threshold alteration means 11, a threshold is changed according to rotational speed ω_{gao} of the basic shaft motor 6, and the threshold according to ω_{gao} is outputted to the judging means 4. In the judging means 4, the comparison test of the differential signal corresponding to the disturbance torque outputted from the differential means 3 and the threshold outputted from the threshold alteration means 11 is performed.

[0042](Embodiment 3) A 3rd embodiment of this invention is described below.

[0043]First, drawing 5 explains composition. About the same composition as the 1st invention, identical codes are attached and it carries out abbreviated [of the explanation]. The disturbance torque computed with the disturbance presumption machine 2 is outputted to the filter part 12 which cuts low frequency like a gravity component, and a gravity component is cut in the filter part 12, and it outputs to the judging means 4. Here, the gravity component contained in disturbance torque is explained. As said robot is shown in drawing 6, when joint operation of the motors 6 from p1 to p2 is performed, the disturbance torque computed serves as a wave as shown as the solid line of drawing 7 (a). Therefore, if the gravity component is contained in the disturbance torque which presumes in this way, the absolute value of a computed value cannot be changed by a gravity paragraph, and a judgment threshold cannot be lowered from the size from which a gravity paragraph serves as the maximum. However, when it filters disturbance torque by the filter part 12, as the solid line of drawing 7 (b) shows, a changed part by gravity can be cut. As a robot shows drawing 6, when it collides with an obstacle by a certain position Pa during operation, the disturbance torque wave when not performing filter processing turns into a wave as shown by the dotted line of drawing 7 (a). However, the disturbance torque wave at the time of performing filter processing turns into a wave as shown by the dotted line of drawing 7 (b). Therefore, as shown in drawing 7 (a) and drawing 7 (b), in time $T_{s'}$ from the time T_s from a collision occurrence when not performing filter processing to a collision judgement, and a collision occurrence when filter processing is

performed to a collision judgement, it turns out that it becomes $T_s > T_s'$ clearly.

[0044](Embodiment 4) A 4th embodiment of this invention is described below.

[0045]First, drawing 8 explains composition. About the same composition as the 1st invention, identical codes are attached and it carries out abbreviated [of the explanation].

[0046]The mean value calculating means 13 computes the average of the disturbance torque within the fixed time for every fixed time by considering disturbance torque from the disturbance presumption machine 2 as an input, and outputs average disturbance torque.

Whenever the main force of the average disturbance torque from the mean value calculating means 13 is carried out, the memory measure 14 memorizes it and outputs it after fixed time.

The computing element 15 searches for the difference of the disturbance torque from the disturbance presumption machine 2, and the average disturbance torque from the memory measure 14, and outputs it to the judging means 4. In the judging means 4, the output and threshold of the computing element 15 are compared and a collision judgement is performed.

[0047]Drawing 9 explains in detail. Drawing 9 (a) shows disturbance torque and its average.

The section of the constant interval T_a is provided on a time-axis, and if the section when the present time belongs is made into the section n by making n into an integer, the section in front of the i natural numbers will be made into section $n-i$. $T_{dn}(t)$ shows the disturbance torque in the section n , and $TD(n-1)$ shows the average disturbance torque in the section $n-1$. Drawing 9 (b) indicates a difference with average disturbance torque $TD(k-1)$ in the section in front of one to be the disturbance torque $T_{dk}(t)$ in the section k ($k = \dots, n-2, n-1, n, \dots$) from the section when the $T_{dk}(t)$ belongs.

[0048]The threshold for judging a collision occurrence, [the conventional method] As drawing 9 (a) shows, and drawing 9 (b) shows to setting up more greatly than the maximum of $T_d(t)$ according to the 4th embodiment of this invention, what is necessary is just larger than a difference with the average disturbance torque in the section in front of one from the present disturbance torque and the section when it belongs. That is, according to the 4th embodiment of this invention, the threshold for judging a collision occurrence can be set up smaller than conventional it, therefore can detect a collision occurrence quickly.

[0049]Although the thing in the section in front of two or more may be used for the average disturbance torque which takes a difference with the present disturbance torque $T_d(t)$, the way in the case of using the average disturbance torque in the section in front of one can set up the threshold for collision detection smaller.

[0050](Embodiment 5) A 5th embodiment of this invention is described below.

[0051]First, drawing 10 explains composition. About the same composition as the 4th invention, identical codes are attached and it carries out abbreviated [of the explanation].

[0052]The mean value calculating means 16 according to speed computes the average of the disturbance torque in the time intervals for every time intervals which change according to the

working speed V of a robot by considering disturbance torque from the disturbance presumption machine 2 as an input, and outputs average disturbance torque.

[0053]Drawing 11 explains in detail. Drawing 11 (a) shows the working speed of a robot, and drawing 11 (b) shows the disturbance torque and its average at that time. A point which is different from drawing 9 (a) about drawing 11 (b) is a point that the section of time changes according to the working speed of a robot. About the point of others, such as numerals, it shall have the same meaning as drawing 9 (a). Although it is a setting method of the section of time, For example, he is trying to say that the section which considers the time as beginning is set up according to the speed in a certain time, the next section is set up and this is successively repeated according to the speed in the time at the time in the end of the section in drawing 11 (a) and drawing 11 (b). The length of the section is carrying out the method of a setup which becomes small, so that speed is large at this time.

[0054]Drawing 11 (a) and drawing 11 (b) show signs that the rate of change of the posture of a robot becomes large and the rate of change of the detected disturbance torque also becomes large, so that speed becomes large.

[0055]Drawing 11 (c) shows a difference with the average disturbance torque in the section in front of one from the section when $T_d(t)$ shown by drawing 11 at this time (b) and its $T_d(t)$ belong. The method of a setup of the threshold for collision detection is as the same as a 4th embodiment of this invention showed.

[0056]Here, a difference with the average disturbance torque in the section in front of one is shown in drawing 11 (e) from the section when $T_d(t)$ which shows drawing 11 (d) the disturbance torque and its average at the time of not depending the section of time on speed but presupposing that it is fixed by drawing 11 (d), and its $T_d(t)$ belong. The working speed of the robot at this time presupposes that it is the same as what was shown by drawing 11 (a).

[0057]When the section of time to average disturbance torque is changed according to speed and it is made for the section of the time to become so short that speed be large so that drawing 11 (c) and drawing 11 (e) may be compared and understood, It turns out that the threshold for collision detection can be made still smaller to the case where did not depend the section of time on speed but it is fixed.

[0058](Embodiment 6) A 6th embodiment of this invention is described below.

[0059]First, as shown in drawing 12, when the robot which is performing two sets of coordination operation collides, a mutual robot performs protection processing to a collision occurrence in the place where estimated disturbance torque exceeded at least one threshold among the mutual motor 6 which are all the motion axes, and the motor 7. Next, drawing 13 explains composition. In each axial control part 100, the disturbance torque of all the motors that constitute the robot which is performing coordination operation is computed. And it is connected by the means of communication 101 between each control part including between

each robot. The means of communication 101 comprises the high order judging means 13 and the high order instruction generation part 14. And the value of the disturbance torque computed in all the axial control parts 100 is outputted to the high order judging means 13. The high order judging means 13 performs the comparison test of the threshold beforehand set up for every axis, and the disturbance torque computed in each axial control part 100. Shortly after disturbance torque exceeds a threshold also with any 1 axis at this time, the high order judging means 13 outputs the judgment of a collision occurrence to the high order instruction generation part 14. The high order instruction generation part 14 outputs instructions of collision protection processing to all the motors, shortly after recognizing a collision judgement. Thus, a collision can be detected by a motor with the highest detection power because the one instruction generation part 14 manages the disturbance torque of all the motors which performs coordination operation, and all the motors can perform collision protected operation promptly.

[0060](Embodiment 7) A 7th embodiment of this invention is described below.

[0061]First, as shown in drawing 14, when it collides with the obstacle 19 during operation with the robot which comprises the motor 6, the motor 7, the link 8, and the fixed stand 9 to which the load 10 was attached, disturbance torque computed by the motor 6 and the motor 7 is set to T_{d6} and T_{d7} , respectively. These total is set to T_{da} , and when the threshold to which the total T_{da} of the disturbance torque of all the axes was set is exceeded, it judges with the collision having occurred. Next, drawing 15 explains composition. In order to explain simply, it explains based on the composition of the robot shown by drawing 14.

[0062][first the means of communication 102 which performs communication between each motor which constitutes a robot] It comprises the high order judging means 17 which performs the comparison with the disturbance torque sum means 20, and total of the disturbance torque computed from said disturbance torque sum means 20 and the total threshold set up beforehand, and the high order instruction generation part 18 which performs instruction generation to all the motion axes. next, the motor 6 and the motor 7 -- calculation of disturbance torque T_{d6} and T_{d7} is performed in each axial control part 100. And the disturbance torque sum means 20 computes the total T_{da} of the disturbance torque of all the axes by the disturbance torque computed for every axis, and it outputs to the high order judging means 17. If the comparison with the total T_{da} of disturbance torque and total threshold α_{th} set up beforehand was performed and T_{da} is over total threshold α_{th} , the high order judging means 17 will be judged to be a collision occurrence, and will require execution of protection processing of the high order instruction generation part 18. The high order instruction generation part 18 outputs the instructions for performing protection processing to the axial control part 100 of each motor, shortly after receiving the demand of protection processing execution from the high order judging means 17.

[0063] Here, make α_6 into the threshold of the collision judgement of the motor 6, and let α_7 be a collision judgement threshold of the motor 7. The time T_s from each collision occurrence shown in drawing 16 to a collision judgement shows that the time reduction of the direction judged to be a collision occurrence at the time of $T_d > \alpha_a$ can be clearly carried out to a judgment rather than judging a collision occurrence in the place usually set to $T_d > \alpha_6$, or, and $T_d > \alpha_7$.

[0064]

[Effect of the Invention] So that clearly from the above explanation with the 1st, 6, and 7 the composition and the 1st, 6, and 7 method of this invention, The collision occurrence of a robot is detectable in an instant, and a collision can be detected by the 2nd composition and 2nd method of this invention, without producing malfunction by the inertial force of the other axes at the time of high-speed operation. By the 3rd, 4, and 5 the composition and the 3rd, 4, and 5 method of this invention, without being affected by the influence of the gravity in the posture change of a robot, since calculation of exact disturbance torque is possible, highly precise collision detection can be performed, and it is very useful practical.

[Brief Description of the Drawings]

[Drawing 1] The block diagram showing the composition of a 1st embodiment of this invention

[Drawing 2] The figure showing change and the differential signal of the disturbance torque at the time of a collision occurrence

[Drawing 3] The lineblock diagram of 2 flexibility robot arm for the 2nd embodiment explanation of this invention

[Drawing 4] The block diagram showing the composition of a 2nd embodiment of this invention

[Drawing 5] The block diagram showing the composition of a 3rd embodiment of this invention

[Drawing 6] The lineblock diagram of 2 flexibility robot arm for the 3rd embodiment explanation of this invention

[Drawing 7] The figure showing change of disturbance torque when affected by the influence of gravity

[Drawing 8] The block diagram showing a 4th embodiment of this invention

[Drawing 9] The figure for the 4th embodiment explanation of this invention

[Drawing 10] The block diagram showing a 5th embodiment of this invention

[Drawing 11] The figure for the 5th embodiment explanation of this invention

[Drawing 12] The lineblock diagram of 2 flexibility robot arm for the 6th embodiment explanation of this invention

[Drawing 13] The block diagram showing the composition of a 6th embodiment of this invention

[Drawing 14]The lineblock diagram of 2 flexibility robot arm for the 7th embodiment explanation of this invention

[Drawing 15]The block diagram showing the composition of a 7th embodiment of this invention

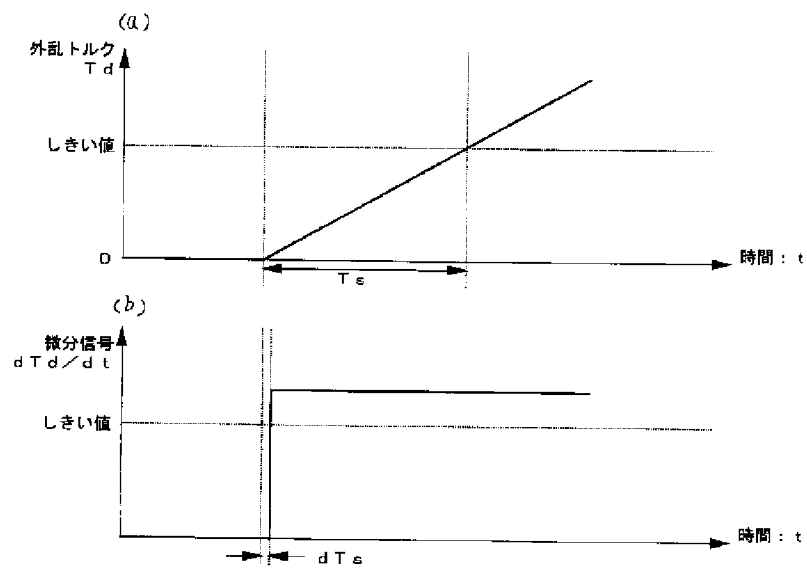
[Drawing 16]The figure showing change of the disturbance torque for the 7th embodiment explanation of this invention

[Drawing 17]The block diagram showing the composition of the conventional collision judgement processing

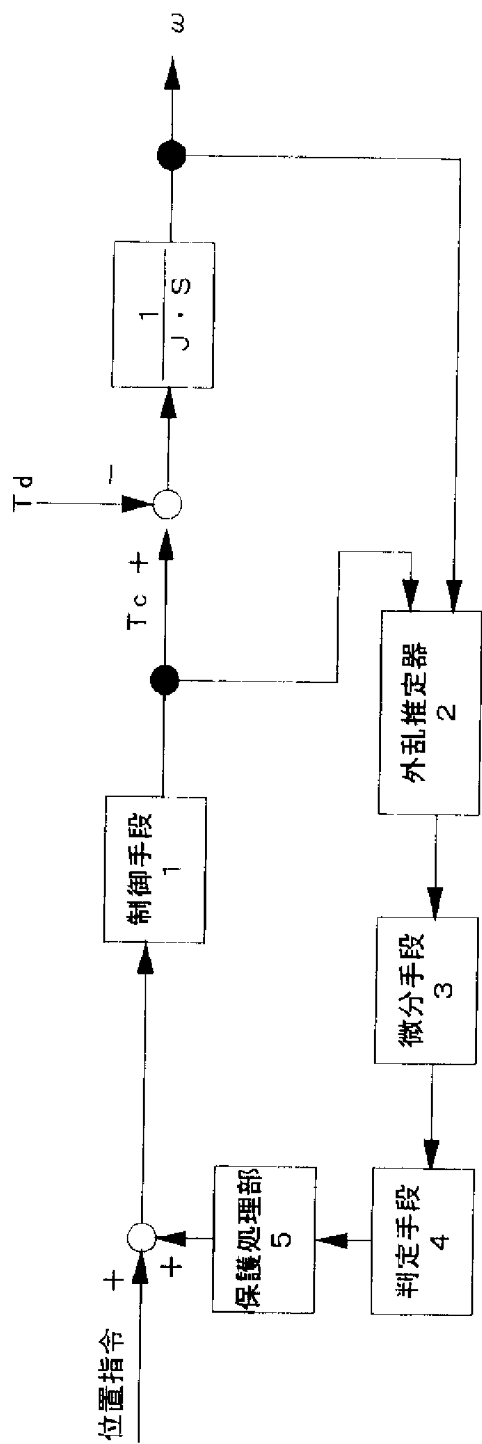
[Explanations of letters or numerals]

- 1 Control means
- 2 Disturbance presumption machine
- 3 Differential means
- 4 Judging means
- 5 Protection treating part
- 6 Motor
- 7 Motor
- 8 Link
- 9 Fixed stand
- 10 Load
- 11 Threshold alteration means
- 12 Filter part
- 13 Mean value calculating means
- 14 Memory measure
- 15 Computing element
- 16 Mean value calculating means according to speed
- 17 High order judging means
- 18 High order instruction generation part
- 19 Obstacle
- 20 Disturbance torque sum means
- 100 Axial control part
- 101 Means of communication
- 102 Means of communication

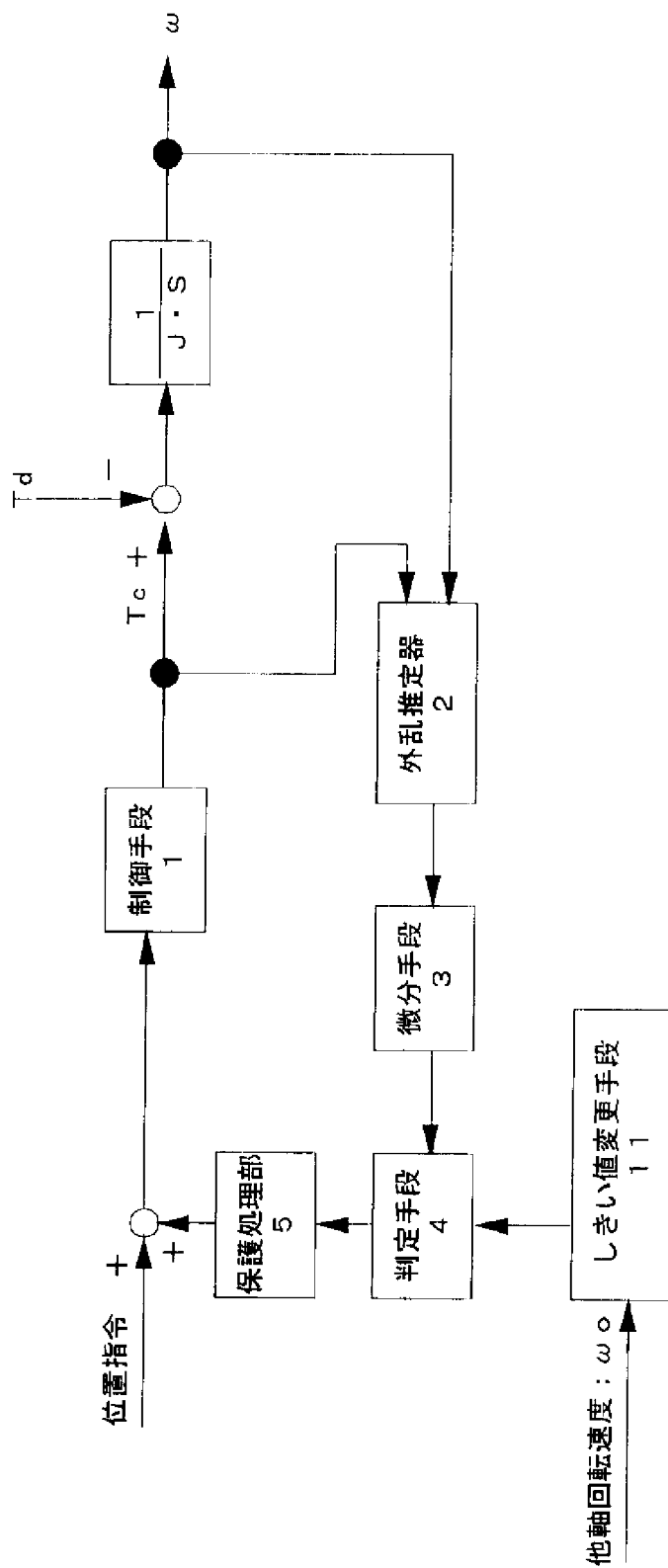
[Drawing 2]



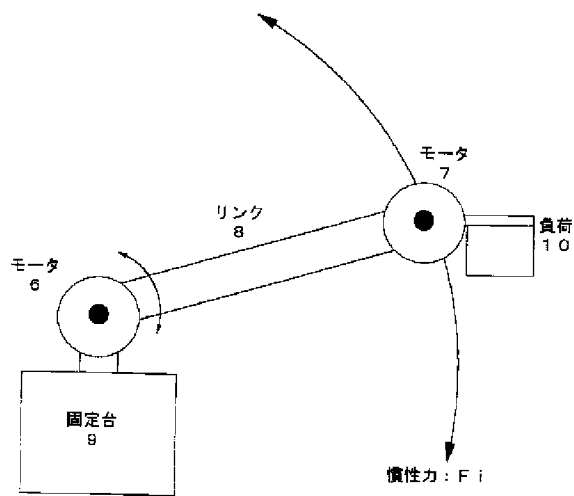
[Drawing 1]



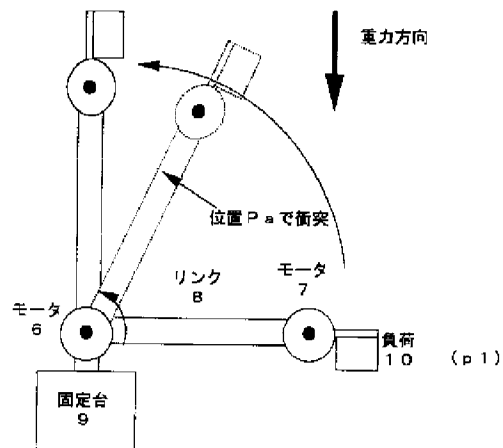
[Drawing 4]



http://dossier1.ipdl.inpit.go.jp/cgi-bin/tran_web_cgi_ejje?u=http%3A%2F%2Fdossier1.ipd... 8/30/2009

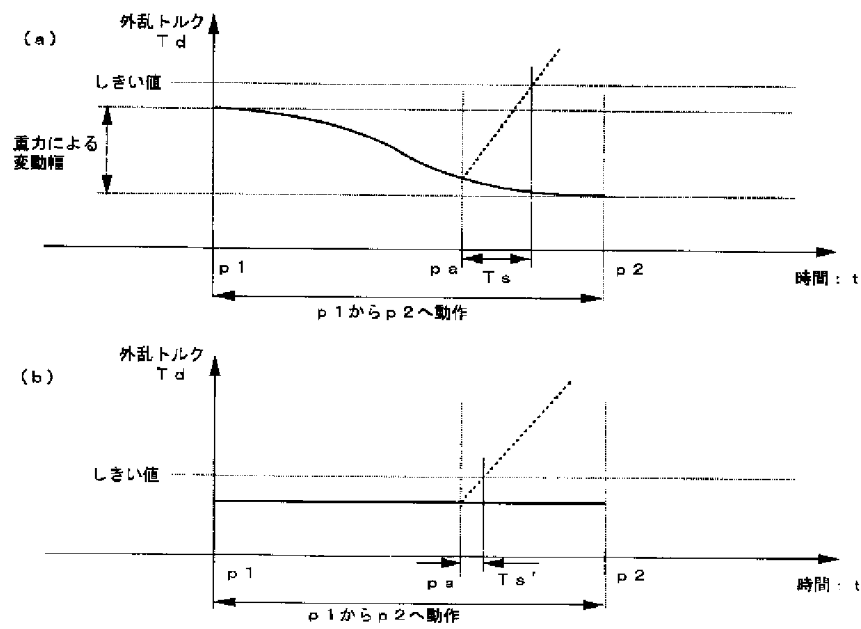


[Drawing 6]
(p 2)

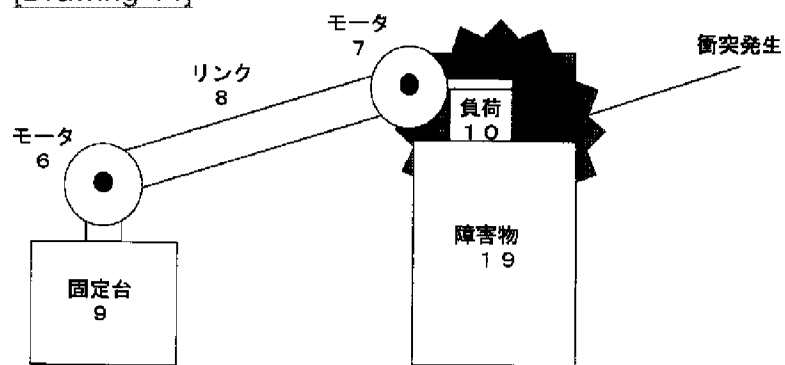


(p 1 から p 2 まで動作)

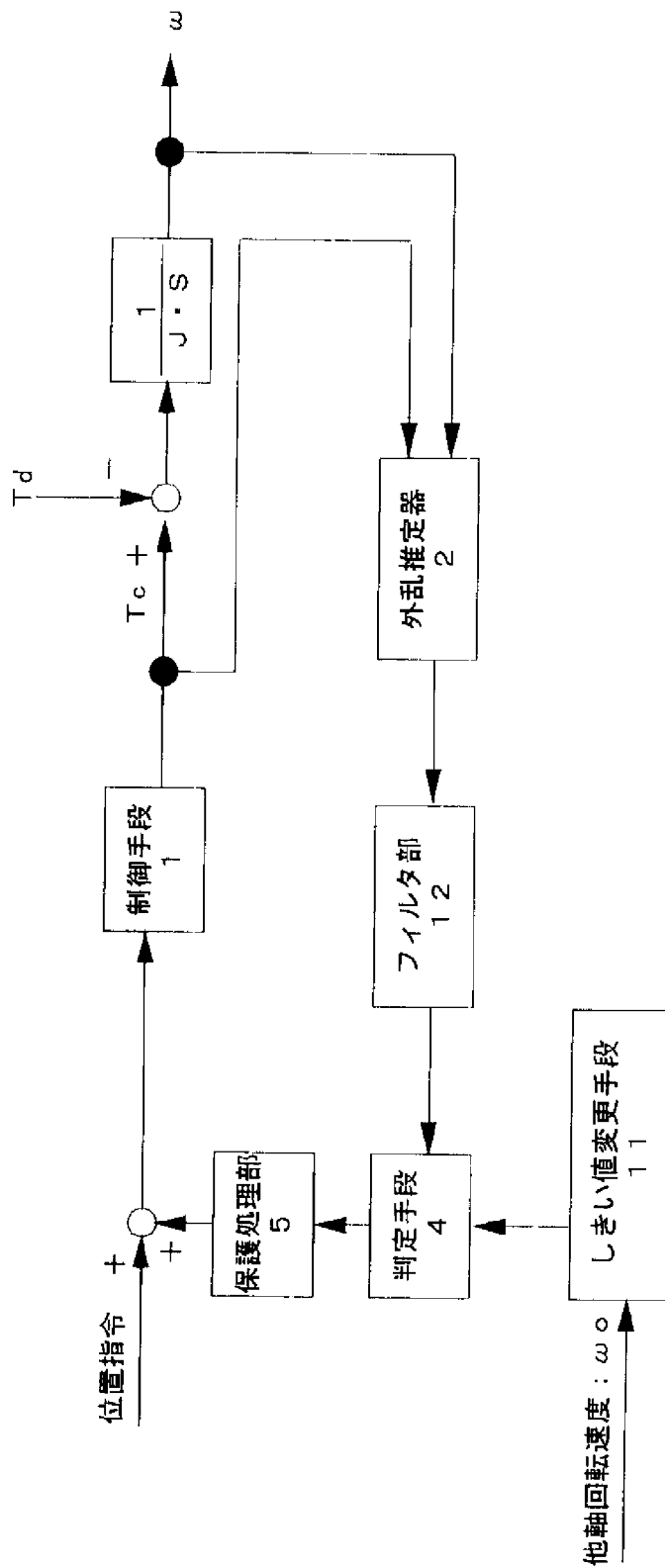
[Drawing 7]



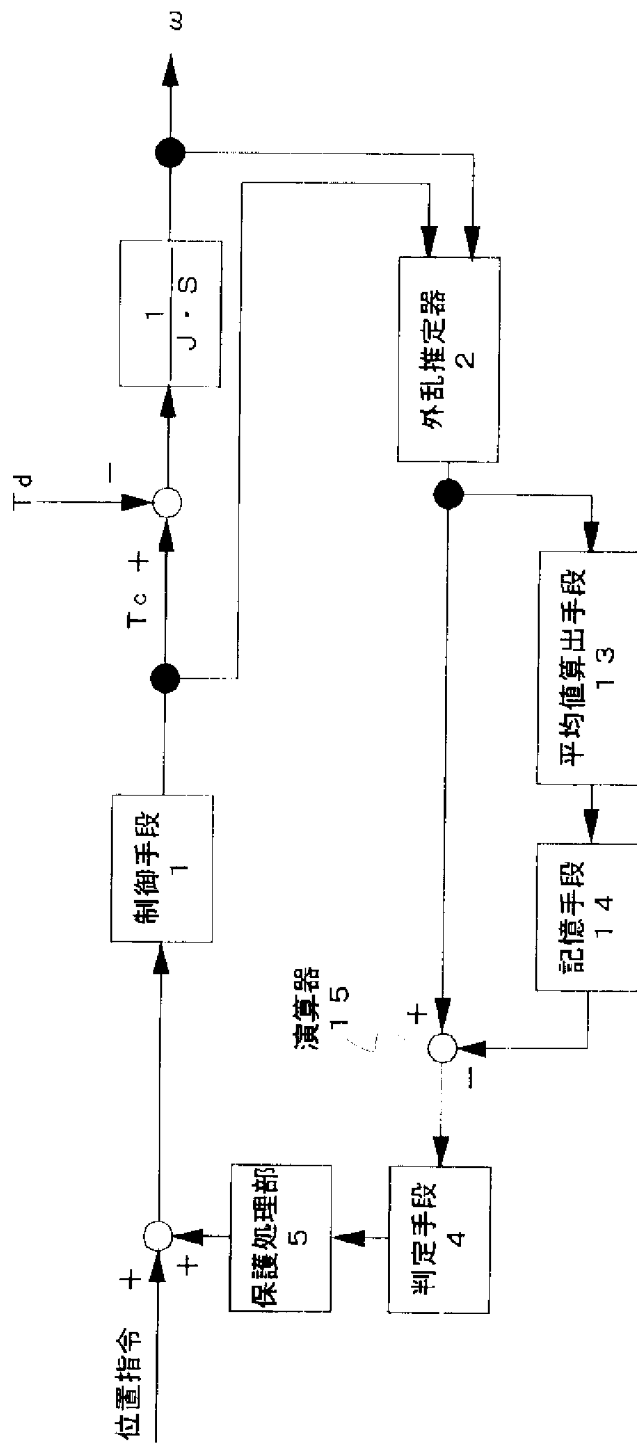
[Drawing 14]



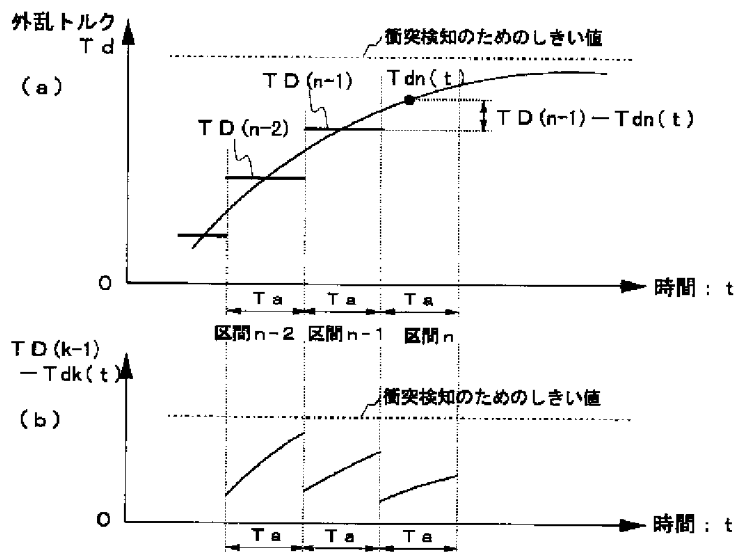
[Drawing 5]



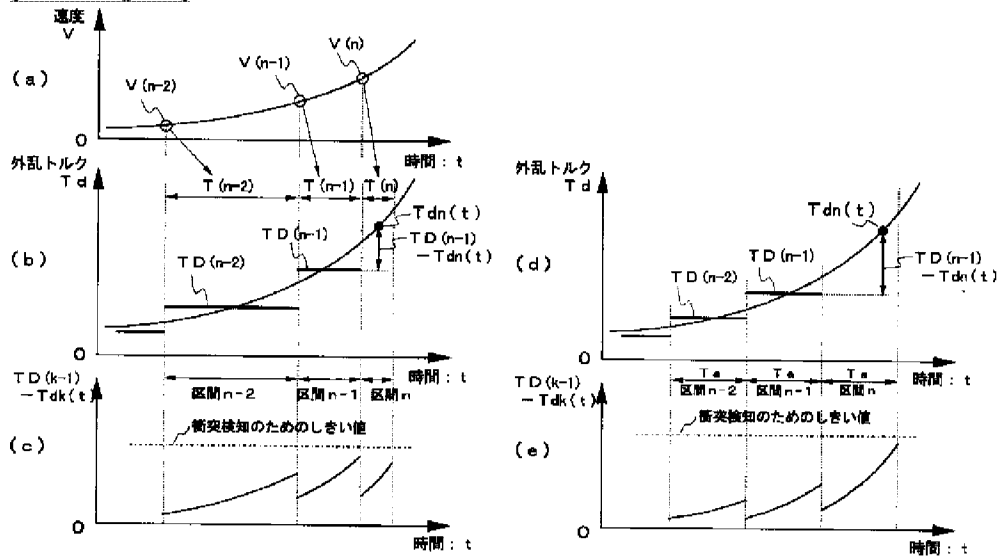
[Drawing 8]



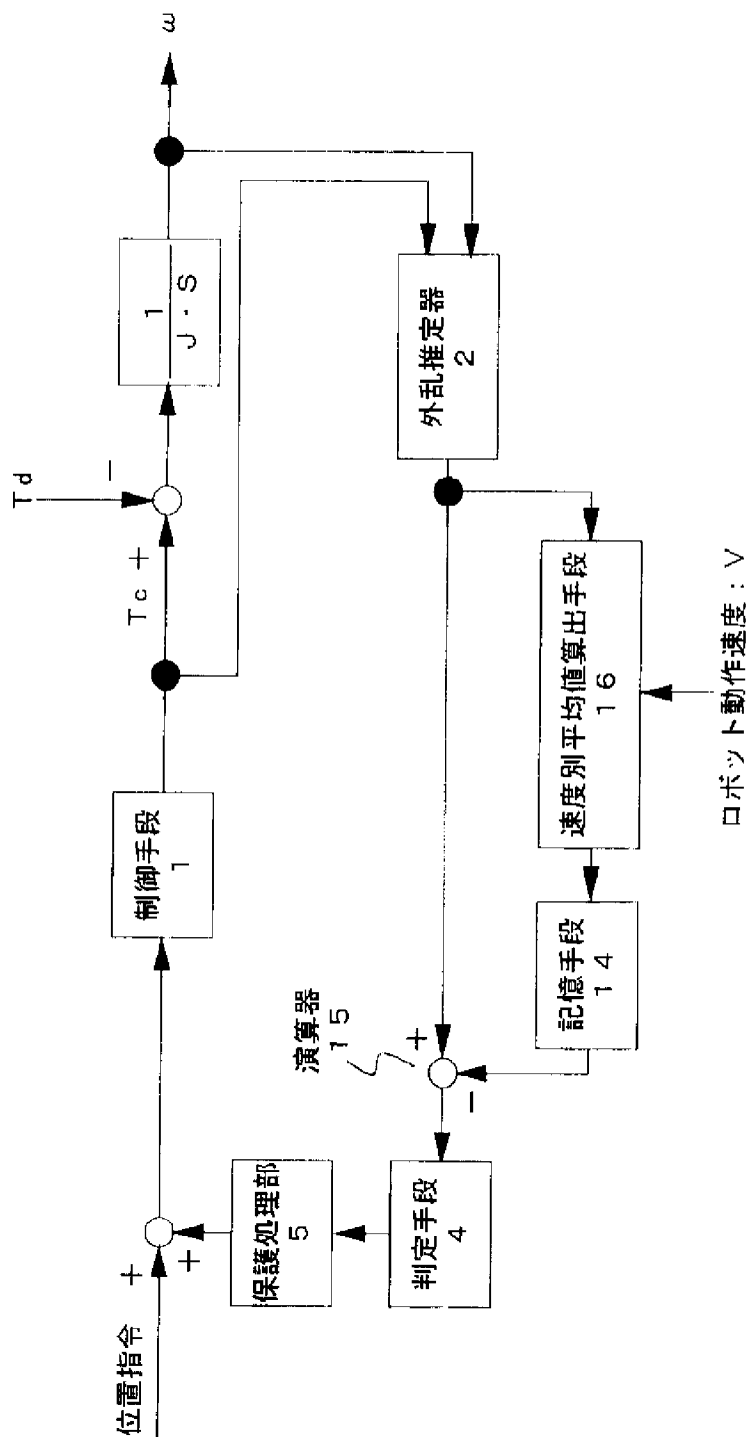
[Drawing 9]



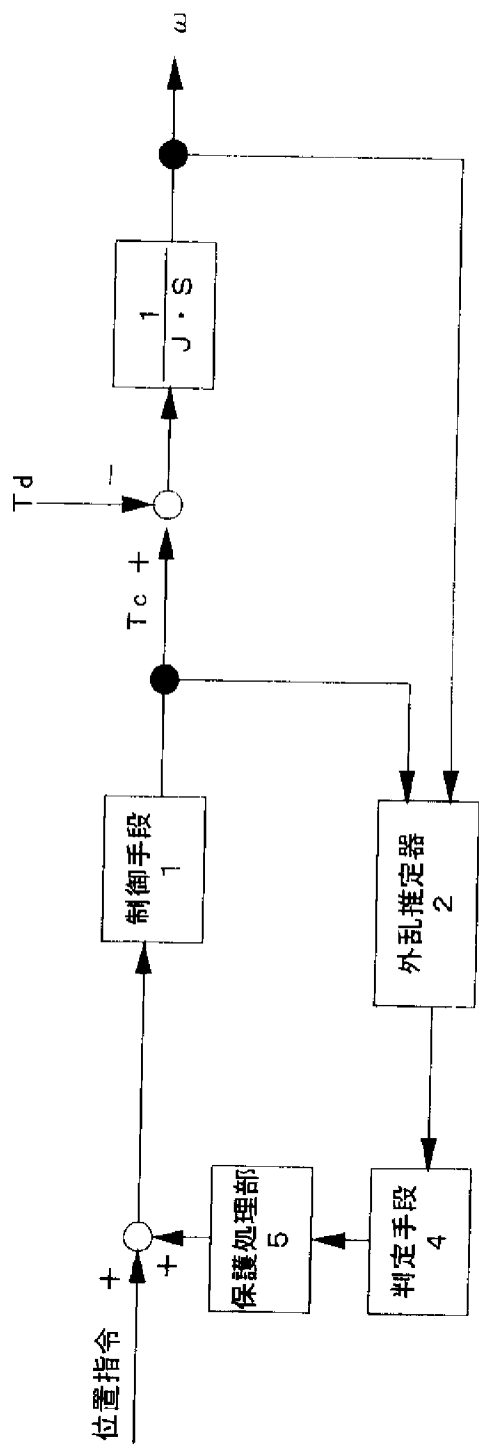
[Drawing 11]



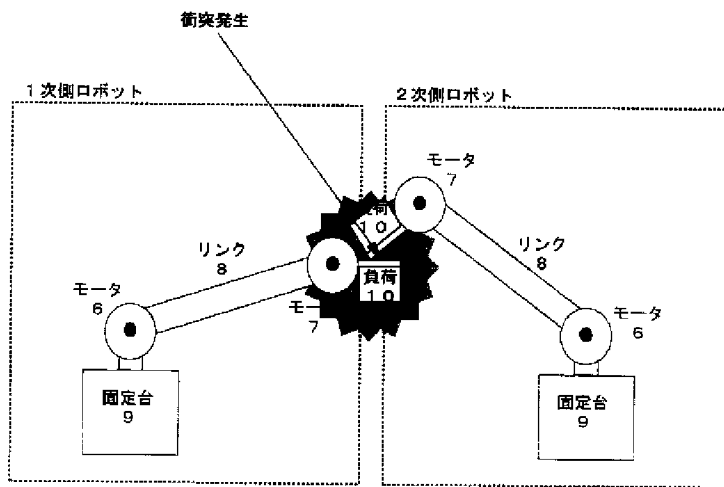
[Drawing 10]



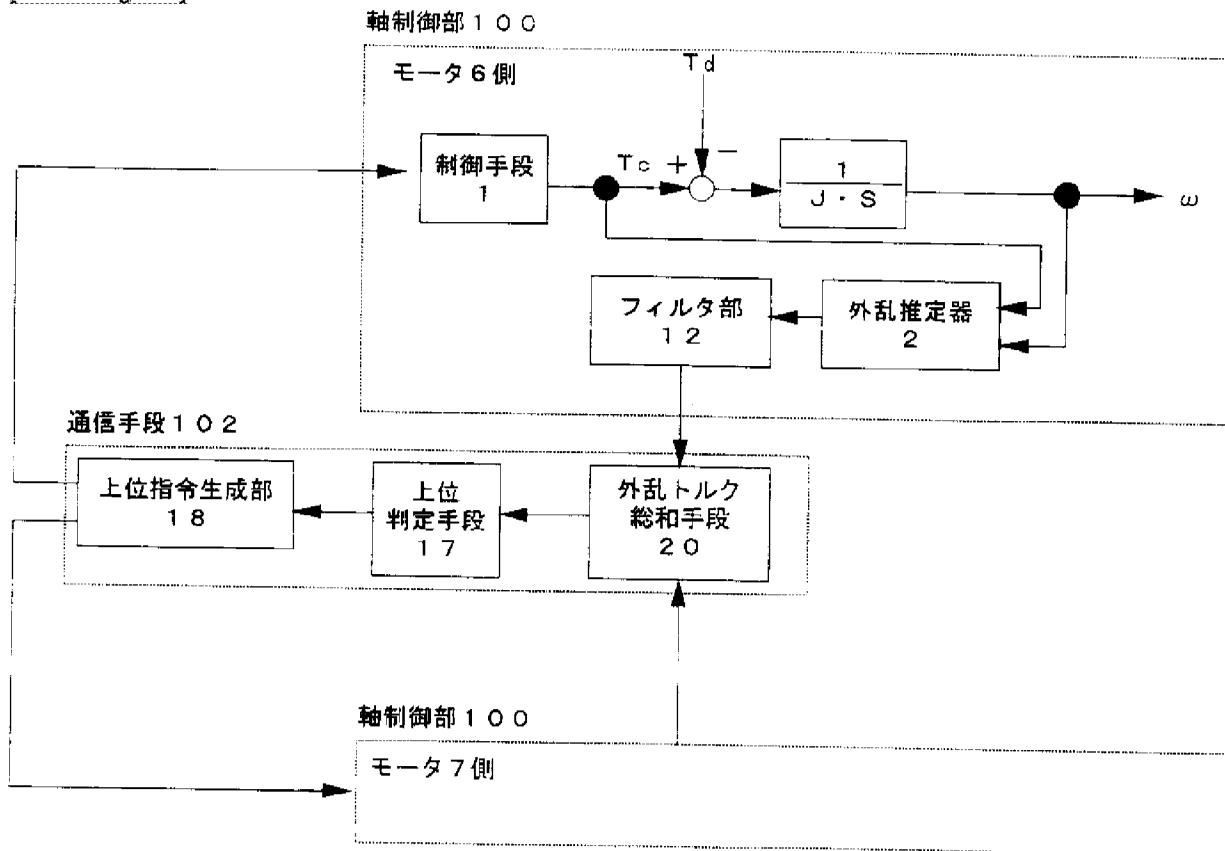
[Drawing 17]



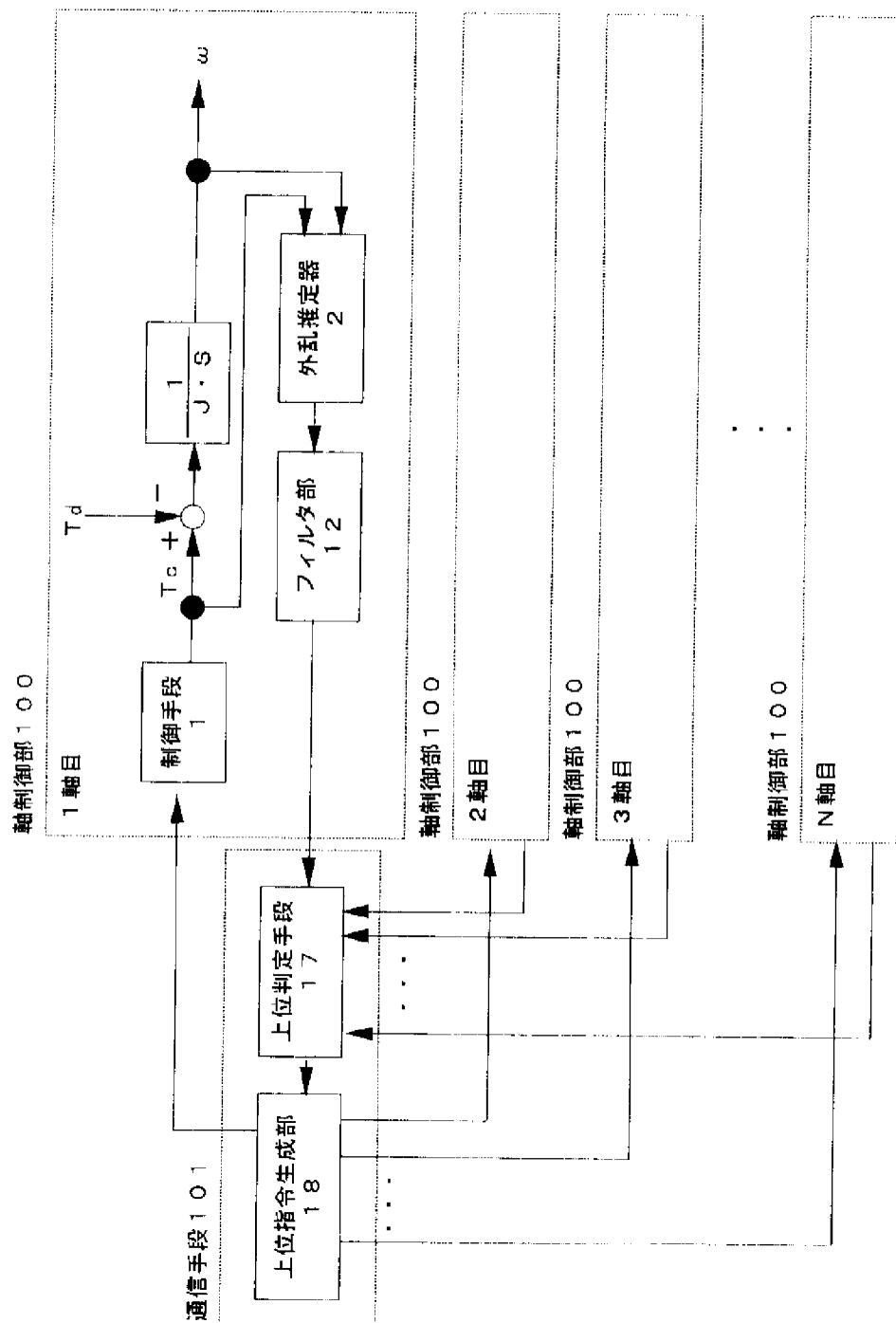
[Drawing 12]



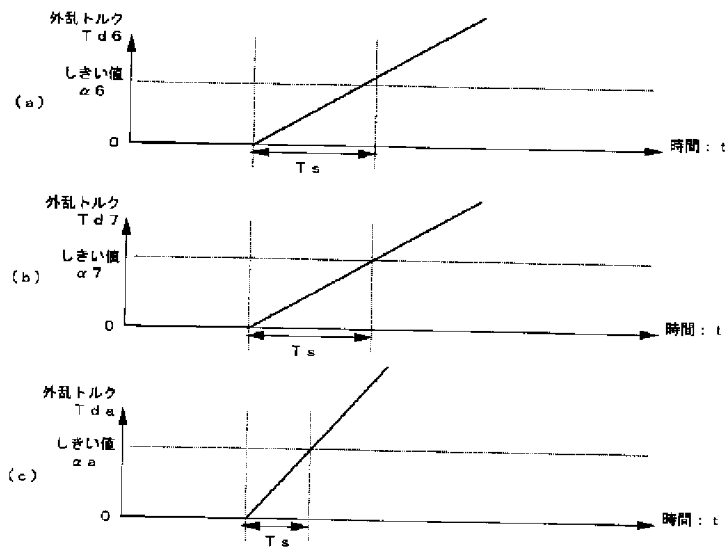
[Drawing 15]



[Drawing 13]



[Drawing 16]



[Translation done.]